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INVESTIGATION OF BOUNDARY FILMS OF LIQUIDS BY BLOWING OFF THE LIQUID

S. S. Novikov

[A Digest]

At the Institute of Physical Chemistry of the Academy of Sciences USSR, B. V. Deryagin, corresponding member, Academy of Sciences, has for a number of years worked on the effect which the surface of a solid body exerts on the depth of adjacent layers of a contiguous liquid. In carrying out investigations in this field, difficulties in connection with the measurement of special mechanical properties of the liquid, particularly that of viscosity, in the vicinity of the solid surface were encountered. The difficulty of measuring the viscosity of lubricants and other liquids under the conditions in question could be eliminated by the method of blowing off the liquid according to a procedure devised by Deryagin.

In this procedure, a stream of air acts upon a film of liquid covering a portion of the flat surface of a solid body. Due to the flow of layers, the liquid assumes the shape of a slanting wedge. V. V. Karasev and E. F. Pichugin have worked out special optical methods for the determination of the shape of that wedge by measuring the intensity and degree of polarization of light reflected from the liquid. A determination of viscosity conditions and of the nature of viscosity changes, with closer approach to the solid surface, can be carried out by this means. It was established that in the boundary layer adjacent to the solid surface the viscosity is uniform, and that it suddenly and sharply changes at a certain distance from the solid surface (the wall), acquiring a different value which corresponds to the normal volume viscosity of the liquid. The liquid in the vicinity of the wall is in a special state. It possesses a greater degree of order than normal, free liquid, and may be regarded a special boundary phase. The thickness and properties of such

boundary phases depend on the composition of the metal which forms the material of the wall, and on the nature of the molecules dissolved in the liquid and possibly being attracted by the wall.

These results explain differences in the lubricating value of oils having the same body viscosity, and clarify the effect of additives which improve the "oiliness" of a lubricant. (The work reported upon here furnishes a good scientific basis for the evaluation and selection of lubricants. As far as the work on lubricants is concerned, E. F. Pichugin collaborated in the investigation.)

Qualitatively distinct boundary phases also form in many other cases. When the pressure of a vapor approaches that of saturation, a polymolecular layer of the substance forming the vapor is built up on materials like glass or quartz, and on thickening, reaches a certain limiting value which corresponds to equilibrium with the vapor (V. V. Karasev, V. I. Gol'danskiy, and M. L. Smolyanskiy). Thus, transition from the boundary phase to the volume phase does not take place gradually but suddenly, by reason of a qualitative difference in the structure of the two phases. The behavior of wedge-shaped layers shows that films which exceed the limiting thickness of the border phase become unstable.

This confirms the connection between incomplete wetting and instability of the film which was postulated on theoretical grounds by Academician A. N. Frumkin, and at the same time agrees with experimental data on polymolecular /layer/ adsorption. Significantly greater thicknesses of boundary films having special properties were found in investigations on vinyl ether polymers and their solutions in oils. When a certain thickness is reached, these films become unstable.

The micropolarization method of measuring the thickness of films was also applied to other thin layers, particularly protective oxide films of metals (M. L. Smolyanskiy). The advantage of the method in this case is that films of uneven thickness can be studied.

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